

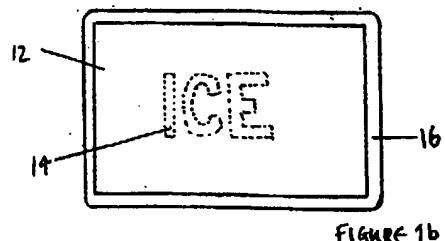
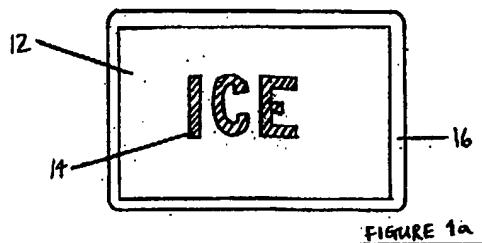
# UK Patent Application (19) GB (11) 2 373 279 (13) A

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(54) Abstract Title  
**Thermochromic display**

(57) The thermochromic display, particularly for use as road signs warning of icy conditions, comprises a first region 12 and a second region 14, the first region having a first colour and the second region having a thermochromic paint applied thereto, the colour of which changes from a second colour to a third colour at a temperature threshold, wherein the thermochromic paint does not comprise liquid crystals. The thermochromic paint preferably displays the second colour above the temperature threshold and the third colour below the temperature threshold. The paint may comprise one or more organic compounds and preferably comprises one or more electron donating chromatic organic compounds, one or more compounds having a phenolic hydroxyl group and one or more compounds selected from the group of higher aliphatic monovalent alcohols, and may further comprise a compound selected from the group of higher aliphatic monovalent acid alcohol esters. The threshold temperature may be in the range of -5 to 5 degrees centigrade and either the second or the third colour may be the same as the first colour. The second region may be in the shape of a written message or a logo or motif. The first region may also be coated in thermochromic paint that changes colour from the first colour to a fourth colour at a temperature threshold. The first colour may be the same as the second colour and the third and fourth colours may be contrasting colours. The display is preferably provided on a board made from a material with high thermal conductivity and be provided with a transparent coating and means for illuminating the display.



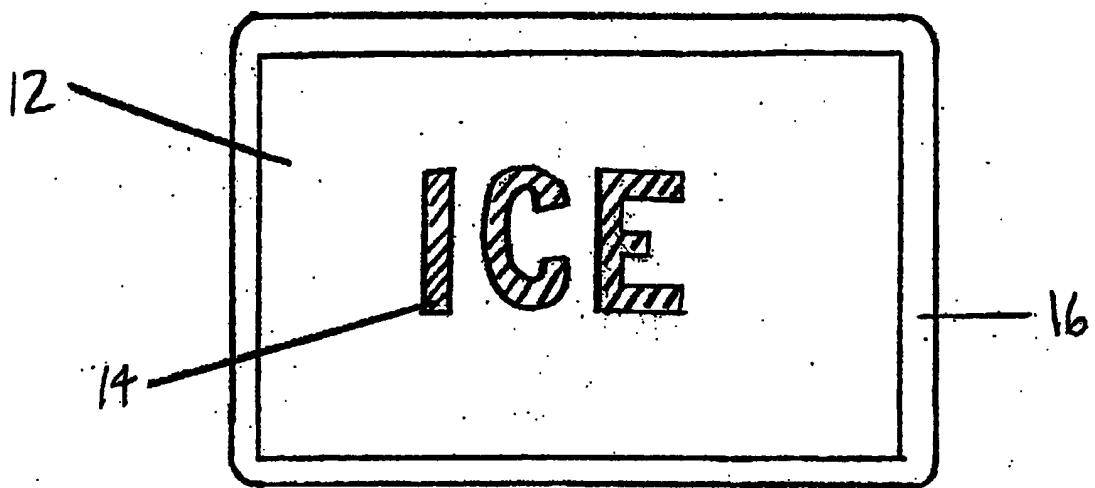


FIGURE 1a

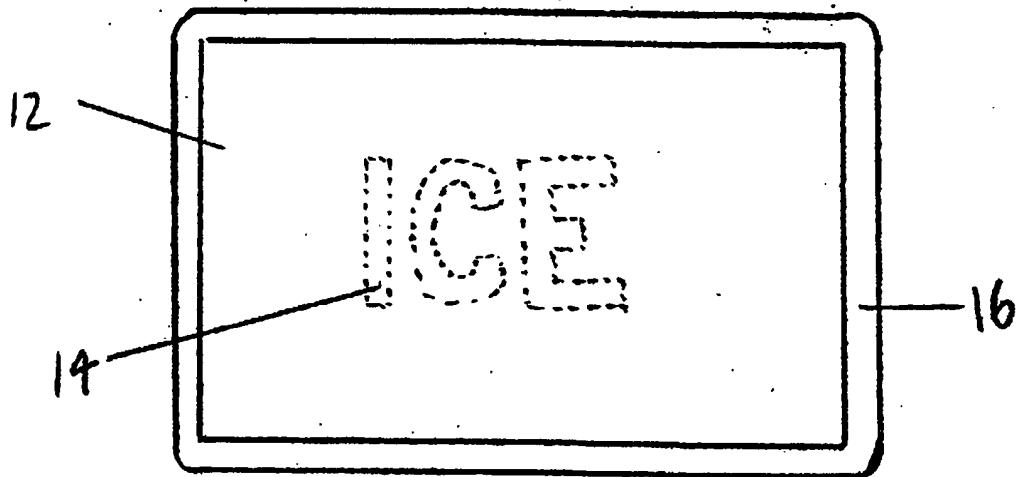


FIGURE 1b

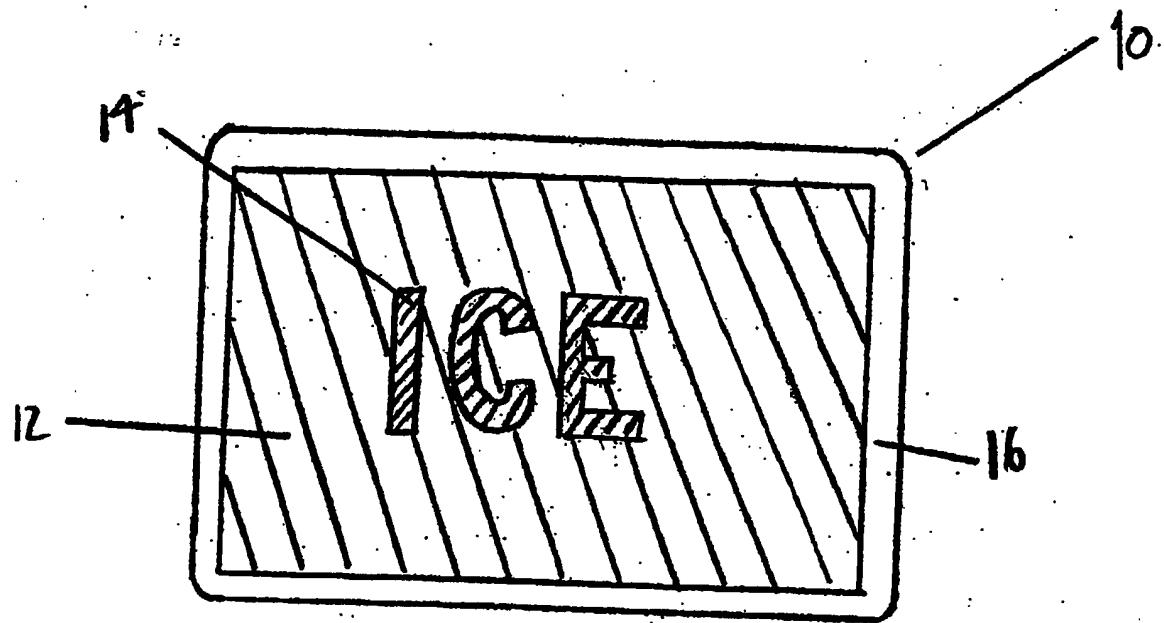


FIGURE 2a

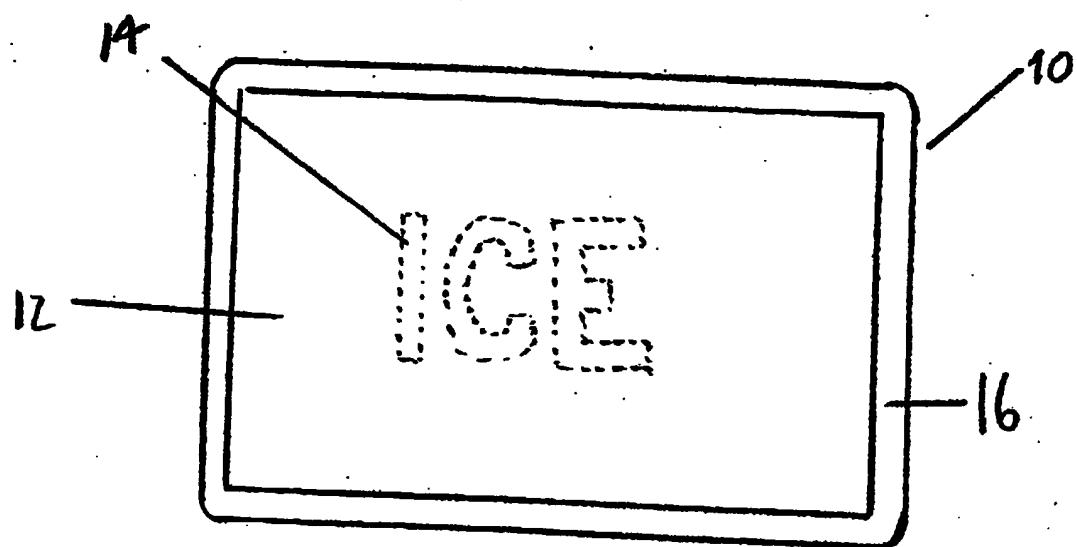


FIGURE 2b

1    **TEMPERATURE SENSITIVE SIGNS**

2

3    The present invention relates to the field of temperature  
4    sensitive indicators and signs, and in particular  
5    temperature sensitive road signs.

6

7    Signs and indicators for displaying information about  
8    changing weather conditions have been known for some  
9    time. For example, displays based on matrices of light-  
10   emitting elements, such as filament emitters or LEDs are  
11   commonplace at roadsides or across motorways. These  
12   displays work in conjunction with a remote centre, which  
13   controls the information displayed according to data on  
14   the weather or driving conditions. Alternatively, the  
15   displays may be provided with their own sensing stations  
16   for the control of the information displayed.

17

18   The matrix displays above are expensive to produce and  
19   maintain, and they have additional problems in that they  
20   require a power source, as well as means for controlling  
21   the information displayed according to locally-sensed  
22   data or signals received from a remote centre.

23

1 Simpler means for displaying changes in weather  
2 conditions have also been devised. For example, GB  
3 2,289,707 discloses road markings and signs that can  
4 indicate the incipient freezing of road surfaces. WO  
5 84/00231 discloses an ice warning sensor with a  
6 temperature sensitive reflective element.

7

8 However, the above display arrangements rely on liquid  
9 crystals for their metachromic properties. Liquid  
10 crystals are not ideally suited to these uses for a  
11 number of reasons. Firstly, they are not particularly  
12 adaptable. That is, the colours and temperature at which  
13 the changes take place cannot be chosen, but are  
14 determined by the properties of the liquid crystal  
15 itself. Thus, if new properties are required, a new  
16 liquid crystal must be synthesised. Secondly, liquid  
17 crystals are readily degraded by coming into contact with  
18 other compounds. In addition, it is often only possible  
19 to obtain colours of a dark hue. Furthermore, liquid  
20 crystals are expensive.

21

22 It would therefore be desirable to have means for  
23 displaying a message to road users upon a change of  
24 temperature, based on compounds other than liquid  
25 crystals.

26

27 According to a first aspect of the invention there is  
28 provided a display comprising: a first region and a  
29 second region, the first region having a first colour and  
30 the second region having a thermochromic paint applied  
31 thereto, the colour of said thermochromic paint changing  
32 from a second colour to a third colour at a temperature  
33 threshold, wherein the thermochromic paint does not  
34 comprise liquid crystals.

1 Preferably, the thermochromic paint displays the second  
2 colour above the temperature threshold, and the third  
3 colour below the temperature threshold,

4

5 The thermochromic paint may comprise one or more organic  
6 compounds.

7

8 The thermochromic paint may comprise:

9 (i) one or more electron donating chromatic organic

10 compounds;

11 (ii) one or more compounds having a phenolic hydroxyl  
12 group; and

13 (iii) one or more compounds selected from the group of  
14 higher aliphatic monovalent alcohols.

15

16 Optionally, a fourth compound may be provided, being:

17 (iv) a compound selected from the group consisting of  
18 higher aliphatic monovalent acid alcohol esters.

19

20 The display may be in the form of a road sign. The  
21 temperature threshold may be in the range -5°C to 5°C.

22 Preferably, the temperature threshold is in the range -1°C  
23 to 1°C.

24

25 Either the second colour or the third colour may be the  
26 same as the first colour.

27

28 The second region may be in the shape of a written  
29 message. Alternatively, or in addition, the second  
30 region may be in the shape of a logo or motif.

31

32 The first region may also be coated with a thermochromic  
33 paint, wherein the thermochromic paint changes colour  
34 from a first colour to a fourth colour at a temperature

1 threshold. Preferably, the first colour and the second  
2 colour are both the same, and the third colour and the  
3 fourth colour are contrasting colours.

4

5 The display may be provided on a board made of a material  
6 with high thermal conductivity. The display may  
7 additionally be provided with a transparent coating.  
8 Means for illuminating the display may be provided.

9

10 An example embodiment of the invention will now be  
11 illustrated with reference to the following Figures in  
12 which:

13

14 Figure 1a shows a sign at a temperature below  $T^\circ$   
15 according to an embodiment of the invention.

16

17 Figure 1b shows the same sign at a temperature above  
18  $T^\circ$ .

19

20 Figure 2a shows a sign at a temperature below  $T^\circ$   
21 according to an alternative embodiment of the  
22 invention.

23

24 Figure 2b shows a sign at a temperature above  $T^\circ$   
25 according to an alternative embodiment of the  
26 invention.

27

28 Figures 1a show and 1b show a sign, generally depicted at  
29 10, comprising a board made up of a plurality of  
30 laminated sheets. The board comprises a backing sheet of  
31 a material with a high thermal conductivity, an  
32 intermediate sheet of a first colour, and a transparent  
33 top sheet. The high thermal conductivity of the backing  
34 sheet results in an even temperature across the board. A

1 border 16 of reflective material surrounds the sign, and  
2 illuminating means (not shown) is provided.

3

4 The intermediate sheet is divided into a first region 12  
5 and a second region 14. The first region 12 is uncoated,  
6 except for the transparent top sheet, and shows the first  
7 colour, which is white in this embodiment. Second region  
8 14 is shaped in the form of the legend "ICE", and is  
9 coated with a thermochromic paint.

10

11 The thermochromic paint is one that does not contain  
12 liquid crystals, and is selected to change colour at a  
13 temperature threshold  $T^\circ$ . Threshold  $T^\circ$  is determined by  
14 the chemical properties of the thermochromic paint, and  
15 in this embodiment is set to be around 0°C. The colours  
16 of the thermochromic paint are also determined by its  
17 chemical make-up. In this embodiment, the second region  
18 14 is colourless at a temperature above  $T^\circ$ , and a dark  
19 colour at a temperature below  $T^\circ$ .

20

21 The sign is placed by a roadside, and when the air  
22 temperature falls below  $T^\circ$ , the thermochromic paint  
23 changes to the dark colour, and the second region becomes  
24 visible on the sign.

25

26 In this way, a warning message is displayed when the  
27 temperature falls to around 0°C, alerting a road user that  
28 ice may be forming on the road surface.

29

30 The thermochromic paint used is for example of the type  
31 described in US Patent document 4,028,118, the contents  
32 of which are incorporated herein by reference. These  
33 thermochromic paints comprise the following components

- 1    (i)    one or more electron donating chromatic organic  
2                compounds;
- 3    (ii)    one or more compounds having a phenolic hydroxyl  
4                group; and
- 5    (iii)    one or more compounds selected from the group of  
6                higher aliphatic monovalent alcohols.

7

8    Optionally, a fourth component may be provided, being:

- 9    (iv)    a compound selected from the group consisting of  
10          higher aliphatic monovalent acid alcohol esters.

11

12   US 4,028,118 describes how the properties of the  
13   thermochromic paint can be varied by changing the  
14   formulation of the paint. Specifically, component (i)  
15   determines the colour of the paint, component (ii) causes  
16   the colour to change, and the temperature threshold is  
17   caused by the amount of and type of components (iii) and  
18   (iv).

19

20   Figures 2a and 2b show a road sign according to another  
21   embodiment. Again, figure 2a shows the sign at a  
22   temperature below  $T^\circ$ , and figure 2b shows the same sign at  
23   a temperature above  $T^\circ$ .

24

25   In this embodiment, the first region 12 is coated with a  
26   second thermochromic paint. This paint is selected so  
27   that it changes colour at the same temperature threshold  
28   as the first paint, but changes to a different colour.  
29   For example, the thermochromic paint in the second region  
30   is colourless at a temperature above  $T^\circ$ , and blue at a  
31   temperature below  $T^\circ$ . The thermochromic paint in the first  
32   region is also colourless at a temperature above  $T^\circ$ , but  
33   is red at a temperature below  $T^\circ$ .

1  
2 In this arrangement, the sign is white and displays no  
3 message to road users at temperatures above  $T^\circ$ . When the  
4 temperature drops to below the threshold  $T^\circ$ , the first  
5 region and the second region both change colour to  
6 contrasting shades. This improves the contrast of the  
7 legend, making the warning clearer to road users.

8  
9 If the low temperature colour in the first embodiment is  
10 sufficiently dark, for example black, then the warning  
11 will be clearly displayed against the white background.  
12 However, in certain circumstances it may be advantageous  
13 to use a different paint in the second region, such as  
14 blue. For example, a thermochromic paint that changes  
15 from colourless to black may be more difficult or more  
16 expensive to produce than a slightly lighter hue.  
17 Alternatively, a black paint might be less stable than a  
18 lighter shade. The second embodiment allows the use of  
19 lighter shades without comprising the legibility of the  
20 warning message.

21  
22 Further arrangements are envisaged. For example, any  
23 message or warning can be displayed by the sign.  
24 Alternatively, the second region may be shaped as a logo  
25 or diagram instead of, or in addition to, the legend. In  
26 addition, alternative colours may be used other than  
27 those described above. In another arrangement, only the  
28 first region is coated with the thermochromic paint, so  
29 that the background changes colour instead of the  
30 lettering in the described embodiment.

31  
32 It is also possible to alter the threshold temperature to  
33 any suitable temperature. For example, it may be found  
34 that the temperature of the road surface is out of step

1 with the temperature of the sign, and therefore the  
2 display will be required to change at a temperature a few  
3 degrees above or below 0°C. For example, the illuminating  
4 means may heat the sign to a certain extent. By changing  
5 the chemical constituents of the paint, the threshold  
6 temperature can be adjusted to a suitable level.

7

8 The present invention provides means for providing  
9 temperature-sensitive warning messages cheaply and simply  
10 to road users, without relying on liquid crystal  
11 materials.

12

13 Further modifications and improvements may be  
14 incorporated without departing from the scope of the  
15 invention herein intended.

1   Claims

2

3   1. A display comprising: a first region and a second  
4   region, the first region having a first colour and  
5   the second region having a thermochromic paint  
6   applied thereto, the colour of said thermochromic  
7   paint changing from a second colour to a third  
8   colour at a temperature threshold, wherein the  
9   thermochromic paint does not comprise liquid  
10   crystals.

11

12   2. A display as claimed in Claim 1 wherein the  
13   thermochromic paint displays the second colour  
14   above the temperature threshold, and the third  
15   colour below the temperature threshold,

16

17   3. A display as claimed in Claim 1 or Claim 2 wherein  
18   the thermochromic paint comprises one or more  
19   organic compound.

20

21   4. A display as claimed in any preceding Claim wherein  
22   the thermochromic paint comprises:

23     (i)   one or more electron donating chromatic  
24        organic compounds;

25     (ii)   one or more compounds having a phenolic  
26        hydroxyl group; and

27     (iii)   one or more compounds selected from the group  
28        of higher aliphatic monovalent alcohols.

29

30   5. A display as claimed in Claim 3 wherein the  
31   thermochromic paint further comprises a compound  
32   selected from the group of higher aliphatic  
33   monovalent acid alcohol esters.

34

- 1   6.   A display as claimed in any preceding Claim,  
2       wherein the display is in the form of a road sign.
- 3
- 4   7.   A display as claimed in any preceding Claim wherein  
5       the temperature threshold is in the range -5°C to  
6       5°C.
- 7
- 8   8.   A display as claimed in any preceding Claim wherein  
9       the temperature threshold is in the range -1°C to  
10      1°C.
- 11
- 12   9.   A display as claimed in any preceding Claim wherein  
13       the second colour is the same as the first colour.
- 14
- 15   10.   A display as claimed in any preceding Claim wherein  
16       the third colour is the same as the first colour.
- 17
- 18   11.   A display as claimed in any preceding Claim wherein  
19       the second region is in the shape of a written  
20       message.
- 21
- 22   12.   A display as claimed in any preceding Claim wherein  
23       the second region is in the shape of a logo or  
24       motif.
- 25
- 26   13.   A display as claimed in any preceding Claim wherein  
27       the first region is coated with a thermochromic  
28       paint, and the thermochromic paint changes colour  
29       from a first colour to a fourth colour at a  
30       temperature threshold.
- 31
- 32   14.   A display as claimed in Claim 12 wherein the first  
33       colour and the second colour are both the same, and

1       the third colour and the fourth colour are  
2       contrasting colours.

3

4     15. A display as claimed in any preceding Claim wherein  
5       the display is provided on a board made of a  
6       material with high thermal conductivity.

7

8     16. A display as claimed in any preceding Claim wherein  
9       the display is provided with a transparent coating.

10

11    17. A display as claimed in any preceding Claim wherein  
12       the display is provided with means for illuminating  
13       the display.



Application No: GB 0204847.8  
Claims searched: 1-17

12

Examiner: Charles Jarman  
Date of search: 15 July 2002

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): E1G (GLB), G5C (CDBX, CJE)

Int Cl (Ed.7): E01F, G09F

Other: Online: WPI, PAJ, EPODOC

**Documents considered to be relevant:**

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2289707 A	(WARD) See whole document.	6
X, Y	US 5503583	(HIPPELY ET AL) See column 5, line 49 - column 6, line 3 particularly.	X:1,2,7-12 Y:3-6, 13,15
X, Y	US 5202677	(PARKER ET AL) See e.g. column 2, lines 3-9 and column 7, lines 37-42.	X:1,2,7-12 Y:3-6, 13,15
Y	US 4142782	(O'BRIAN) See whole document.	13,15
Y	US 4028118	(NAKASUJI ET AL) See particularly column 31, line 66 - column 33, line 2.	3,4,5
Y	JP 8022259 A	(ANZEN KK ET AL) See whole document.	6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.